

NERRS Science Collaborative Progress Report for the Period 3/01/13 through 8/31/13

Project Title: Exploring the cost-effectiveness of restored marshes as filters of runoff pollution in a world of rising seas.

Principal Investigator: Eric Brunden

Project start date: 10/01/12

Report compiled by: Eric Sparks

Contributing team members and their role in the project:

Eric Brunden- Project coordinator

Mike Shelton- Local Collaboration Lead

Dr. Jessica Thompson- Collaboration Advisor

Dr. Just Cebrian- Applied Science Investigator

Dr. Julia Cherry- Applied Science Investigator

George Ramseur- Applied Science Investigator

Dr. Craig Tobais- Additional Investigator

Eric Sparks- Technician

Adam Constantin- Graduate student researcher

Sara Martin- Graduate student researcher

A. Progress overview:

Non-point source nitrogen pollution is a major problem worldwide. This problem is difficult to avert and manage. With previous work we have demonstrated that marshes restored to full coverage (100% plant cover) can filter large amounts of runoff pollution. We do not know, however, the extent of runoff removal by marshes restored to lower levels of coverage as the marshes fill in and increase their coverage. This information is important to devise cost-effective management strategies for reducing runoff pollution through marsh restoration. Such strategies also need to consider sea level rise, as rising seas can alter fringing marshes through increased flooding and/or salinity stress, and by default their capacity to filter runoff pollution. We will conduct a series of experiments to quantify runoff pollution removal by marshes restored to varying degrees of coverage under current and future sea level

scenarios. We will generate different runoff regimes, ranging from intense, short-lived rainfall to prolonged, light drizzle, and quantify nitrogen filtration (loss and retention) as the runoff plume travels through the restored marshes. With the results from the experiments we will carry out cost-effectiveness analyses contrasting the extent of pollution removal versus the cost of marsh construction and upkeep under current and predicted tidal flooding conditions. The ultimate goal is to build a decision support tool that will help managers attain runoff reduction targets through marsh restoration in effective and affordable ways given their time and budget constraints. The decision support tool will also present adaptive strategies to maximize runoff filtration with marsh restoration under rising seas.

For this reporting period we originally had 3 goals, but added 2 more goals as the project progressed. The three original goals were; 1) conduct a flow rate study on the experimental marsh, 2) meet with the MAT to discuss the results from the flow rate study and plans for the nutrient dosing study and 3) conduct a nutrient dosing study. The 2 additional goals were to 4) collect data to gauge weirs ability to mimic different SLR scenarios and 5) develop a survey to gauge public interest and knowledge of marsh restoration and conservation.

The first project goal for this reporting period was to determine the flow rate and dilution of the groundwater experimentally introduced into the plots. This information was necessary to ensure correct sampling times throughout the project and effective capturing of the introduced groundwater after it travels through the plots. During April 2013 a conservative tracer ($425 \mu\text{M}$ of KBr^-) was pumped at a rate of $36 \text{ L}^{-1} \text{ day}^{-1}$ through a subset of vegetated (> 50 % planting density) and non- vegetated plots for 11 consecutive days. Porewater samples were taken from screened wells at the downland edge of each plot. The wells were screened from 5-30 cm below the sediment surface to capture the entire rhizosphere of the marsh plants. Steady state, with regards to bromide concentrations, in the downland wells was reached on the 7th day of pumping for both vegetated and non-vegetated plots (Figure 1). Dilution of the introduced groundwater on day 7 varied from 25 % to 55 % for all plots, thus a high enough proportion of our introduced solution for robust analysis.

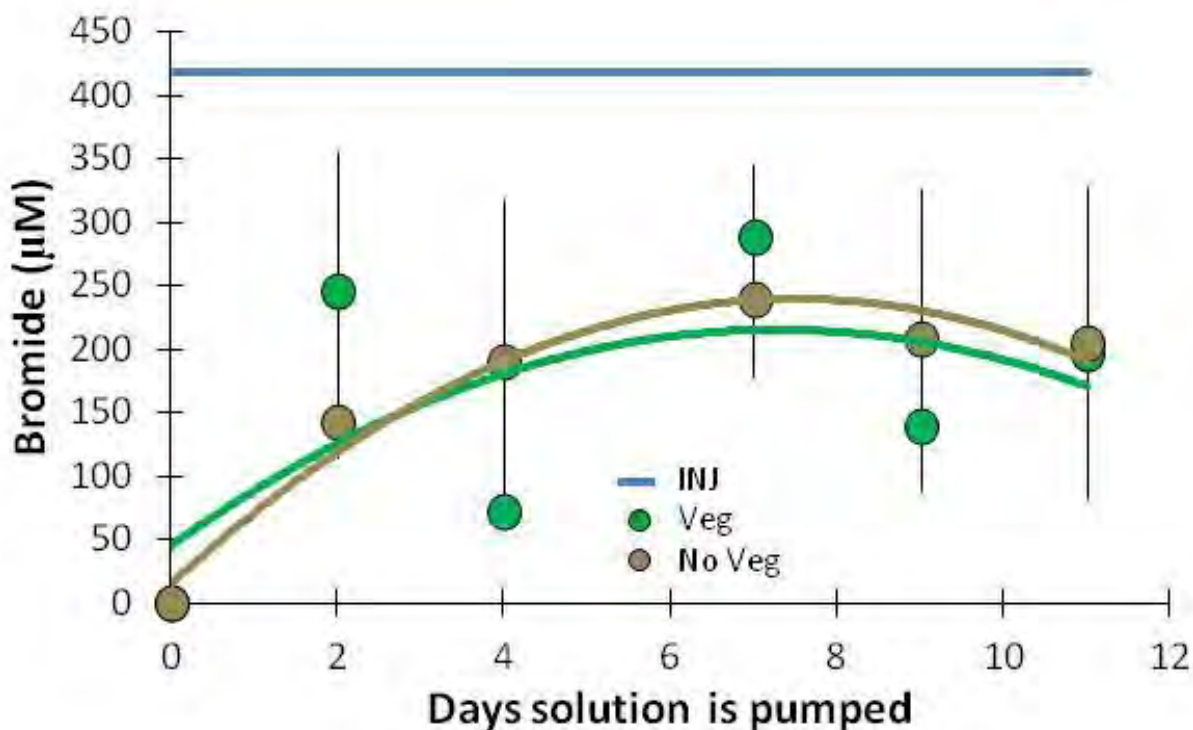


Figure 1. Porewater bromide concentrations in downland wells of vegetated and non-vegetated plots. The blue line is the concentration of bromide in the injectate (INJ) prior to entering the plots. Error bars indicate ± 1 SE.

Another MAT meeting was held on May 9, 2013 at the Weeks Bay Coastal Resource Center. The purpose of this meeting was to present the groundwater travel time and dilution results to the MAT and discuss upcoming plans for the nutrient loading experiments. After presenting the experimental results, the MAT team came to a unanimous decision for flow rates and sampling times to be used in all three scenarios of the nutrient study. Groundwater will be pumped for 7 days at a rate of $36 \text{ L}^{-1} \text{ day}^{-1}$ for the light drizzle scenario, 17 hours at a high flow rate ($398 \text{ L}^{-1} \text{ day}^{-1}$) for the heavy rain event scenario and a low flow rate ($18 \text{ L}^{-1} \text{ day}^{-1}$) over 14 days for the retention pond scenario. All of the pump rates and days of pumping required before sampling were calculated using the results from the travel time study.

Goal 3 for this reporting period is to conduct a round of nutrient addition experiments. These experiments are currently ongoing and are being conducted in all three clusters using the three pumping scenarios described above (retention pond, light drizzle and heavy rain) and follow the same methodology of the travel time/dilution experiment, with the additional measurements of accretion rates, soil organic matter content and plant growth. Target nitrate and bromide concentrations for the incoming groundwater is $200 \text{ } \mu\text{M}$ and $600 \text{ } \mu\text{M}$ respectively.

Goal 4 for this reporting period was not part of the original set of goals, but was developed as the project progressed. From June 28- July 26, data was collected to demonstrate the weirs can mimic varying degrees of SLR. Weirs in each cluster were set to mimic different degrees of SLR (low, mid, high) by altering the drain valve height. Preliminary review of the data show the weirs were successful at mimicking varying degrees of SLR while still retaining natural tidal oscillations. A methodology publication will be submitted in the future to inform other researchers of an in-situ alternative to current methods to mimic SLR.

The final goal for this reporting period was to develop and administer a survey gauging public knowledge and interest in wetland conservation and restoration. This was another goal that was not originally planned for, but developed with the project. The survey is currently distributed online (<https://www.surveymonkey.com/s/LCP3DD2>) with results from completed surveys to soon follow. To date we have approximately 200 responses.

This project has also been invited to be in some publications over this reporting period. One publication is the NOAA Gulf of Mexico Climate Change Adaption Inventory (http://www.csc.noaa.gov/dataservices/ClimateInventory/Search/Exploring_the_costeffe
[ctiveness of restored marshes as filters of runoff pollution in a world of rising se](http://www.csc.noaa.gov/dataservices/ClimateInventory/Search/Exploring_the_costeffe)
[as](http://www.csc.noaa.gov/dataservices/ClimateInventory/Search/Exploring_the_costeffe)), which inventories many climate change related projects along the Gulf of Mexico. This inventory was developed to facilitate the exchange of information to communities developing planning initiatives in response to climate change impacts. Another publication this project will be in is the Gulf Coast Community Handbook. The handbook highlights examples of what agencies are doing to improve resiliency to climate change for habitats around the Gulf of Mexico and is funded by EPA's Climate Ready Estuaries program.

B. Working with Intended Users:

The integration of input from intended users of this research has been integral throughout the entire process of this project. As mentioned in the previous section, we held a MAT meeting to ensure our experimental design was best suited to address the needs of intended end users. The Applied Science team and MAT unanimously came to an agreement to use each of the three experimental clusters to address different scenarios of runoff pollution and finalized the nutrient loading rates based on the travel time experiments. Groundwater will be pumped for 7 days at a rate of $36 \text{ L}^{-1} \text{ day}^{-1}$ for the light drizzle scenario, 17 hours at a high flow rate ($398 \text{ L}^{-1} \text{ day}^{-1}$) for the heavy rain event scenario and a low flow rate ($18 \text{ L}^{-1} \text{ day}^{-1}$) over 14 days for the retention pond scenario. Over the next 6 months, another MAT meeting is planned after the nutrient addition experiments have been analyzed. In that meeting the Applied Science team will share nutrient experiment results with the MAT. The Applied Science

team and MAT will then modify (if necessary) the experimental plan for the next nutrient addition experiment to best suit the MAT's management needs.

C. Progress on project objectives for this reporting period:

All objectives for this reporting period were achieved or are currently in progress and these objectives were: 1) conduct a flow rate study on the experimental marsh, 2) meet with the MAT to discuss the results from the flow rate study and plans for the nutrient dosing study and 3) conduct a nutrient dosing study. The 2 additional goals were to 4) collect data to gauge weirs ability to mimic different SLR scenarios and 5) develop a survey to gauge public interest and knowledge of marsh restoration and conservation; both of these additional goals have been completed or are currently ongoing as well. See the Progress Overview section (A) for a more detailed description of the completion of project objectives timeline. In the next 6 months, we have 2 project objectives: 1) synthesize the results from the nutrient experiment and survey and 2) have a MAT meeting to present and discuss the nutrient experiment and survey results. A tentative schedule for meeting these project objectives is to finish the nutrient experiment field work by mid October, synthesize the results from the nutrient experiment and survey from mid October to mid November and have another MAT meeting in mid November. After November, planning and preparation for the next nutrient experiment will be conducted.

D. Benefits to NERRS and NOAA:

A direct benefit to NERRS, NOAA and the general public, for this reporting period, is the development of approximately 75 square meters of restored marshland that was previously the steep bank of a dredged canal. Crabs, birds and fish are frequenting the restored marsh. Also several fishermen have been fishing by boat around the seaward edge of the marsh to catch these attracted fish. Another benefit is the exposure we obtain from the location of clusters 1 and 2. Both of these clusters are located near a frequently used boat launch and several of these boaters have walked up to the site to see restoration progress. This interaction between the general public and scientist at the research site is a great opportunity to educate the general public on the experiments and benefits of marshes as well as receive input as to how the public values marshes. These interactions led to the development of the coastal marshland awareness survey described above. Inclusion of this project in publications such as the NOAA Gulf of Mexico Climate Change Adaption Inventory and Gulf Coast Community Handbook also directly benefits NOAA and the NERRS since these publications increase the reach of this project to decision makers across the United States.